

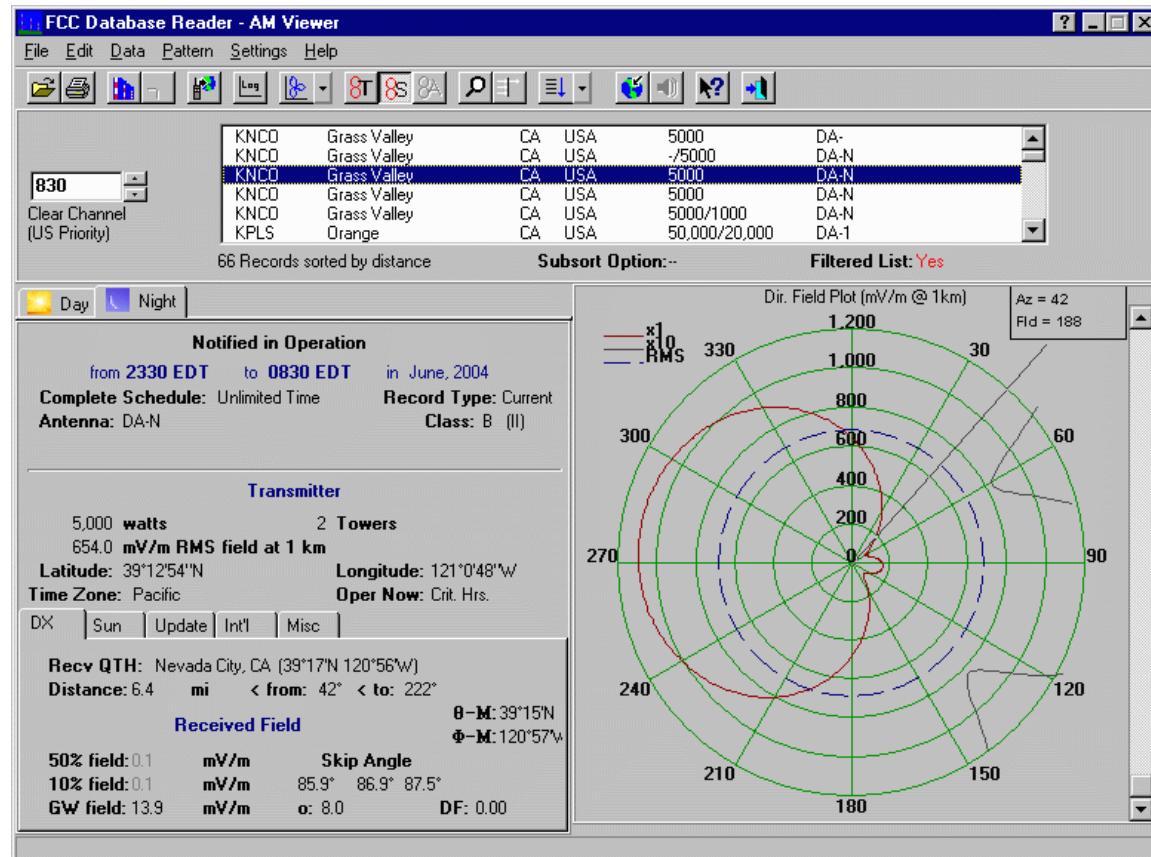
Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of:)
Digital Audio Broadcasting Systems) MM Docket No. 99-325
And Their Impact on the Terrestrial)
Radio Broadcast Service)

Comments of David L. Hershberger

I am an electrical engineer. I have been working in broadcasting since 1969 and have been designing broadcast equipment continuously since 1975.

Nighttime testing of IBOC operation has already created harmful interference to reception of my local AM station. For this reason I oppose nighttime IBOC in its current form.

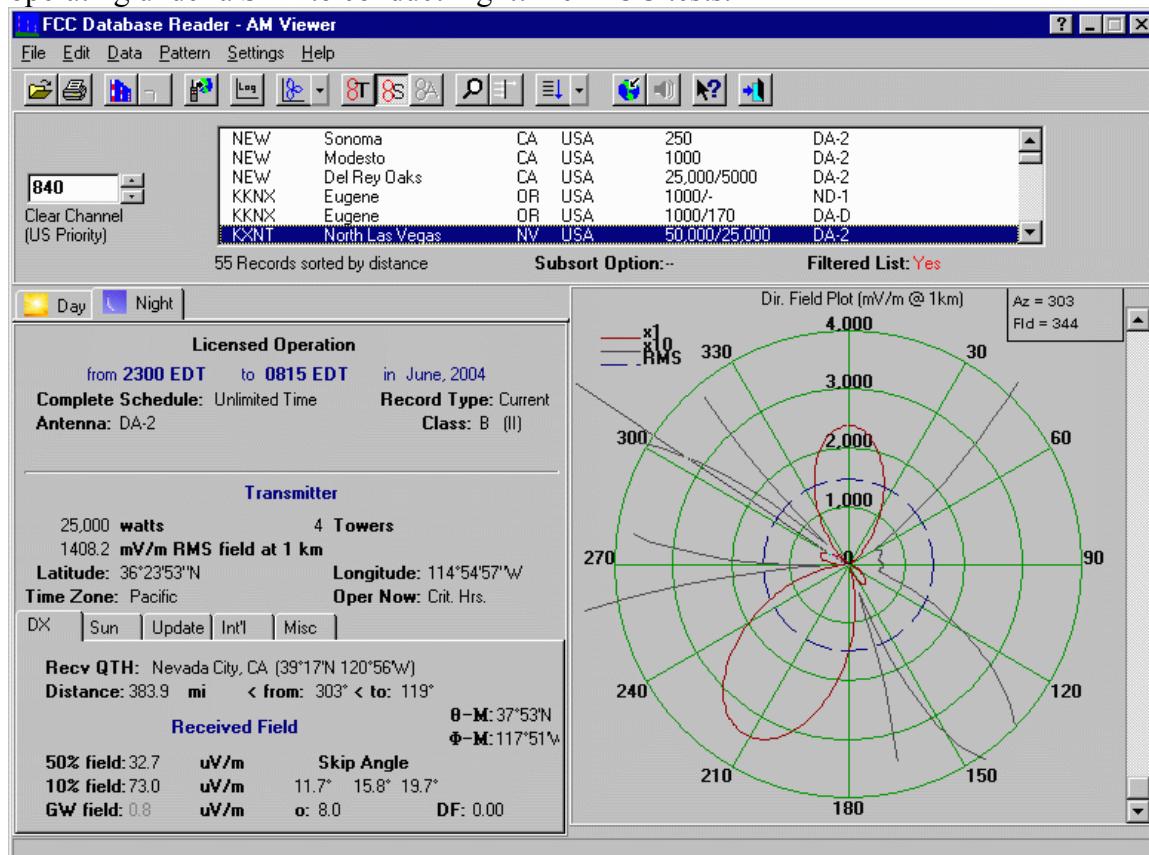


I live 6.4 miles from the transmitter site of my local AM station. As shown by the FCC database reader in the figure above, with standard pattern augmentations, the nighttime ERP in my direction is theoretically 413 watts. The theoretical groundwave field strength

at my house is approximately 13.9 millivolts per meter. The radial line shown at an azimuth of 42 degrees shows my location in the nighttime pattern. The local AM station is KNCO in Grass Valley, California, on 830 kHz.

On March 3, 2004, I turned on the radio one night and heard a very strong white noise type of interference on KNCO. Although I immediately suspected that somebody was running IBOC at night, I used my home-made synchronous detector to find that the interference was being received on KNCO's lower sideband only. I tuned to 850 kHz and found that KOA's upper sideband only was receiving similar interference.

Apparently the interference was originating from a station on 840 kHz. I later found out that the interference was coming from KXNT in Las Vegas (840 kHz), which was operating under a STA to conduct nighttime IBOC tests.



KXNT operates with 25 kW at night with a directional pattern. KXNT's transmitter site is 383.9 miles from my location. Their directional pattern has a null in my direction. KXNT's pattern should result in only 32.7 microvolts/meter (50% field probability) and 73.0 microvolts/meter (10% field probability) at my location. The radial line at 303 degrees azimuth in the figure above shows my location in KXNT's pattern.

So, if KXNT were the only interferer with KNCO, and if KXNT were co-channel instead of adjacent channel, the received signal to noise ratio should be 45.6 dB or better 90% of the time. This would be just fine and dandy.

But I estimate that the received S/N ratio during the nighttime tests conducted by KXNT was only 15 to 20 dB. This makes for a very unpleasant listening experience. At this level of interference, many people would just turn the radio off. It certainly qualifies as harmful interference.

So why was the IBOC interference much stronger than expected? It is well known in the radio engineering community that AM directional antennas are adjusted for proper operation at the station's carrier frequency. The pattern characteristics, including the depth of nulls, may vary substantially at sideband frequencies used by IBOC – 10 to 15 kHz away from the carrier.

I have posted short MP3 files (slightly less than three minutes) showing what the interference sounded like during the March tests. This file was recorded on March 3, 2004, shortly after 10 PM local time:

<http://www.w9gr.com/kncoiboc.mp3>

This file was recorded several days earlier (February 23, 2004) when KXNT was not testing IBOC, also shortly after 10 PM local time:

<http://www.w9gr.com/knco.mp3>

These recordings were made using a Harris RF590 receiver with 16 kHz IF bandwidth, using an external home-built synchronous detector (described in detail in an article I wrote which appeared in the April 1982 issue of Popular Electronics Magazine). The sampling rate of the MP3 files is 11.025 kHz, making the effective IF bandwidth something slightly less than 11 kHz. Also inline was a Behringer DSP 9024 digital audio processor being used as a noise gate and limiter. So the IBOC noise has been reduced somewhat by the noise gate function.

Although this situation is anecdotal, I believe it would be a common occurrence if nighttime IBOC were given blanket approval. I believe that there will be many other people who cannot receive their local AM stations' signals 6.4 miles away because of interference originating 384 miles away from directional antennas that do not work correctly at IBOC sideband frequencies.

Nighttime IBOC should not, in general, be allowed for the following reasons:

1. The Commission's allocation structure and spectral masks are based on analog spectral characteristics, where average sideband energy falls off with increasing displacement from the carrier frequency. Analog signals occupy the full 20 kHz of bandwidth only on a statistically transient basis – for example during sibilance. IBOC energy, by contrast, is always present, causing the signal to always fully occupy three channels (30 kHz) of bandwidth. In other words, the spectral mask established for AM is not appropriate for the statistics of digital signals.

2. Directional antenna systems generally are not characterized over three channels' bandwidth. The directional pattern obtained for the analog signal will often be substantially degraded at IBOC sideband frequencies.

The basic engineering necessary to show the extent of nighttime IBOC interference simply has not been done.

Nighttime digital broadcasting should only be authorized in pure digital-only mode in a single channel of bandwidth – i.e. +/- 5 kHz from carrier. Effectively, AM stations should be restricted to using the DRM system at night, unless HD-Radio can also offer a mode that occupies no more than 10 kHz of bandwidth. In other words, AM stations at night should choose whether they wish to broadcast in analog **or** digital, but not both. Neither the allocation structure nor most directional antenna systems were intended for operation over three channels' bandwidth. Indeed, directional antenna systems are not even characterized for such extreme bandwidth.

Nighttime IBOC may be allowed in some instances – only when a licensee can show that (1) the directional antenna, if used, maintains its pattern over three channels of bandwidth, and (2) harmful interference to adjacent channels will not be introduced anywhere within the service area of adjacent stations.

It would be folly to allow such wide scale interference on the air at night, and to expect directional antenna systems to do something they were never intended to do, and to do so without even characterizing these directional antenna systems.

I should be able to hear a 413 watt ERP signal 6.4 miles from the transmitter without harmful interference. But with IBOC, I cannot.

My remaining comments are more philosophical in nature, but still pertinent.

First, I have to wonder whether the major advances in single carrier digital reception (e.g. Linx Electronics) for digital television may also be applied to radio. If so, then use of OFDM for digital radio may be inferior to digital radio transmission with a single carrier (or a small number of carriers).

Second, because of developments in both modulation and coding (compression) methods, the receivers for any digital broadcasting system should be completely software definable. Moreover, updates to receivers should be done over the air, invisibly to the user of the receiver. In other words, we should standardize the receiver, not the transmitted signal. The HD Radio system unfortunately guarantees obsolescence by defining the transmitted signal instead of the receiver. Specifying (and locking down) the transmitted signal is archaic thinking in the context of modern technology.

Third, it seems that the philosophy of digital radio development has lagged behind that of HDTV by some two decades. In the 1980s, Sarnoff Laboratories tried to develop the television equivalent of IBOC – combining a NTSC television channel with a HDTV

augmentation signal transmitted on another channel. The NTSC signal also contained some of the HDTV augmentation, encoded in such a way that conventional receivers would mostly reject it. Fortunately, this debacle was soon abandoned for technical reasons. HDTV became a revolutionary, rather than an evolutionary development. I believe that the same should be done for radio. Broadcasting should be done using either analog or digital means, but not both at the same time on the same channel, or more accurately, using three channels instead of one. Trying to do both simultaneously simply corrupts both the analog and the digital signals. The same conclusion that was reached for television (going entirely digital and abandoning analog) may be the best thing for radio too.

Respectfully submitted,

David L. Hershberger
P. O. Box 2163
Nevada City, California 95959-9136

dave@w9gr.com